Discovery and Engineering of Bioactive Natural Products

Dr. Xue (Sherry) Gao

Fall 2018

Contact Information

Instructor: Dr. Xue (Sherry) Gao
Office: BRC 315
Email: xue.gao@rice.edu
Office Hours: Thursdays 11 am-12 pm

Course Objectives and Learning Outcomes

Natural products are extraordinarily important resources and have served as valuable leads for drug discovery. This course will survey the discovery and biosynthesis of natural products as well as engineering approaches to modify and optimize the production of natural products and their derivatives. Topics include:

1) The discovery and characterization of biosynthetic gene clusters and pathways for major classes of natural products, including polyketides, nonribosomal peptides, ribosomally synthesized and posttranslationally modified peptides, terpenes and steroids, alkaloids etc.
2) Bioinformatic analysis and genome mining for novel natural products: Introduction of cutting-edge bioinformatic approaches for natural product discovery from microbiomes, including human microbiome, earth microbiome, marine microbiome and others.
3) Engineering of biosynthetic enzymes for biocatalysis: Directed evolution and rational design of biosynthetic enzymes, enzyme immobilization, whole cell biocatalysts, and fermentation for natural and semi-synthetic natural product production.
4) Metabolic engineering for natural products and their derivatives: Engineering biosynthesis of natural products, synthetic biology approaches, and *De Novo* pathway design for pharmaceutical production.

Required Texts and Materials

No textbook is required. This course will be based on the most recent literature which will be assigned. Basic knowledge on molecular biology, chemical biology, protein structure, and protein engineering, etc., is a prerequisite.

Exams and Papers

Mid-term Exam and Final-term Paper

Grade Policies

Letter Graded;

30% Presentation, Discussion and Participation in Friday's Discussion Sections;

30% Mid-term Exam;

40% Final Term Paper.

Absence Policies

Students are required to attend all the lectures on Wednesdays and all the literature presentation/discussion sessions on Fridays and arrive in a timely manner. Students who are absent without prior notification to the instructor may not receive points for the corresponding section.

Rice Honor Code

In this course, all students will be held to the standards of the Rice Honor Code, a code that you pledged to honor when you matriculated at this institution. If you are unfamiliar with the details of this code and how it is administered, you should consult the Honor System Handbook at http://honor.rice.edu/honor-system-handbook/. This handbook outlines the University's expectations for the integrity of your academic work, the procedures for resolving alleged violations of those expectations, and the rights and responsibilities of students and faculty members throughout the process.

Disability Support Services

If you have a documented disability or other condition that may affect academic performance you should: 1) make sure this documentation is on file with Disability

Support Services (Allen Center, Room 111 / adarice@rice.edu / x5841) to determine the accommodations you need; and 2) talk with me to discuss your accommodation needs.

Syllabus Change Policy

This syllabus is only a guide for the course and is subject to change with advanced notice.

Course Schedule

Wednesday, August 22, 2018

[Overview of the history and motivation of natural product's research and course requirements]

Friday, August 24, 2018

[Overview of the section requirements and sign-up subgroups for leading the discussion sections]

Wednesday, August 29, 2018

[Lecture 1: Overview of how Nature makes small molecules using enzymes]

Friday, August 31, 2018

[Literature presentation and discussion section]

Wednesday, September 5, 2018

[Lecture 2: Introduction and mechanistic investigation of biosynthetic enzymes involved in the biosynthesis of major classes of natural products I -- Polyketides and Fatty Acids]

Friday, September 7, 2018

[Literature presentation and discussion section]

Wednesday, September 12, 2018

[Lecture 3: Introduction and mechanistic investigation of biosynthetic enzymes involved in the biosynthesis of major classes of natural products II -- Nonribosomal Peptides]

Friday, September 14, 2018

[Literature presentation and discussion section]

Wednesday, September 19, 2018

[Lecture 4: Introduction and mechanistic investigation of biosynthetic enzymes involved in the biosynthesis of major classes of natural products III -- ribosomally synthesized and posttranslationally modified peptides]

Friday, September 21, 2018

[Literature presentation and discussion section]

Wednesday, September 26, 2018

[Lecture 5: Introduction and mechanistic investigation of biosynthetic enzymes involved in the biosynthesis of major classes of natural products IV -- terpenes and steroids, alkaloids etc]

Friday, September 28, 2018

[Literature presentation and discussion section]

Wednesday, October 3, 2018

[Lecture 6: Bioinformatic analysis and genome mining for novel natural products I]

Friday, October 5, 2018

[Literature presentation and discussion section]

Wednesday, October 10, 2018

[Lecture 7: Middle term review]

Friday, October 12, 2018

[Middle term]

Wednesday, October 17, 2018

[Lecture 8: Bioinformatic analysis and genome mining for novel natural products II]

Friday, October 19, 2018

[Literature presentation and discussion section]

Wednesday, October 24, 2018

[Lecture 9: Engineering of biosynthetic enzymes for biocatalysis I -- Directed evolution of biosynthetic enzymes]

Friday, October 26, 2018

[Literature presentation and discussion section]

Wednesday, October 31, 2018

[Lecture 10: Engineering of biosynthetic enzymes for biocatalysis II -- Rational design of biosynthetic enzymes]

Friday, November 2, 2018

[Literature presentation and discussion section]

Wednesday, November 7, 2018

[Lecture 11: Engineering of biosynthetic enzymes for biocatalysis III -- Enzyme immobilization, whole cell biocatalysts, and fermentation for natural and semi-synthetic natural product production.]

Friday, November 9, 2018

[Literature presentation and discussion section]

Wednesday, November 14, 2018

[Lecture 12: Metabolic engineering for natural products and their derivatives I -- Engineering biosynthesis of natural products]

Friday, November 16, 2018

[Literature presentation and discussion section]

Wednesday, November 21, 2018

[Lecture 13: Metabolic engineering for natural products and their derivatives II -- Engineering biosynthesis of natural products using synthetic biology approaches]

Friday, November 23, 2018 - NO CLASS

Wednesday, November 28, 2018

[Lecture 14: Metabolic engineering for natural products and their derivatives III -- Engineering biosynthesis of natural products by *De Novo* pathway design for pharmaceutical production]

Friday, November 30, 2018

[Literature presentation and discussion section]